

## INQUIRY SKILLS

- ☐ Questioning
- ☐ Hypothesizing
- ☐ Predicting
- ☐ Planning
- ☒ Conducting
- ☒ Recording
- ☒ Analyzing
- ☒ Evaluating
- ☒ Communicating

**Investigation 8.5.1****Titration Analysis of Vinegar**

Consumer products are required by law to have the minimum quantity of the active ingredient listed on the product label. Companies that produce chemical products usually employ analytical chemists and technicians to monitor the final product in a process known as quality control. Government consumer affairs departments also use chemists and technicians to check products, particularly in response to consumer complaints.

In this investigation, you will be the quality control chemist. You have received a report that a local high-school cafeteria has been serving watered-down vinegar to the students. Your purpose is to test the acetic acid concentration of the vinegar to discover whether it has been diluted (i.e., below the 5.0% W/V acetic acid indicated on the purchased container). Complete the **Analysis** and **Evaluation** sections of the report.

**Question**

What is the molar concentration of acetic acid in a sample of vinegar?

**Prediction**

The manufacturer claims on the label that the vinegar contains 5.0% acetic acid, which translates into a 0.87 mol/L concentration of acetic acid. The concentration of acetic acid in the vinegar sample should be the same.

**Experimental Design**

A sample of vinegar from the school cafeteria is diluted by a factor of 10 to make a 100.0-mL solution. The diluted solution is titrated with a standard sodium hydroxide solution using phenolphthalein as the indicator.

**Materials**

lab apron  
 eye protection  
 $\text{NaOH}_{(\text{aq})}$   
 vinegar  
 phenolphthalein  
 wash bottle of pure water  
 two 100-mL or 150-mL beakers  
 250-mL beaker  
 100-mL volumetric flask with stopper  
 50-mL buret  
 10-mL volumetric pipet  
 pipet bulb  
 ring stand  
 buret clamp  
 stirring rod  
 small funnel  
 two 250-mL Erlenmeyer flasks  
 meniscus finder



Wear eye protection and a lab apron.

At these dilutions, the chemicals are fairly safe and can be disposed of down the drain.

## Procedure

1. Obtain about 30 mL of vinegar in a clean, dry 100-mL beaker.
2. Pipet one 10.00-mL portion into a clean 100-mL volumetric flask and dilute to the mark.
3. Stopper and invert several times to mix thoroughly.
4. Obtain about 70 mL of  $\text{NaOH}_{(\text{aq})}$  in a clean, dry, labelled 100-mL beaker.
5. Set up the buret with  $\text{NaOH}_{(\text{aq})}$ , following the accepted procedure for rinsing and clearing the air bubble.
6. Pipet a 10.00-mL sample of diluted vinegar into a clean Erlenmeyer flask.
7. Add 1 or 2 drops of phenolphthalein indicator.
8. Record the initial buret reading to the nearest 0.1 mL.
9. Titrate the sample with  $\text{NaOH}_{(\text{aq})}$  until a single drop produces a permanent change from colourless to faint pink.
10. Record the final buret reading to the nearest 0.1 mL.
11. Repeat steps 6 to 10 until three consistent results are obtained.

## Analysis

- (a) Answer the Question: What is the molar concentration of acetic acid in a sample of vinegar?

## Evaluation

- (b) Evaluate your evidence: How confident are you that your techniques and measurements resulted in good evidence?
- (c) Evaluate the Prediction: Assuming the manufacturer's claim is accurate, is someone in the cafeteria diluting the vinegar? Include an accuracy calculation (percentage difference) in your evaluation.